CHAPTER

12 Kinetic Theory of Gases

- **Boyle's law:** If m and T are constant

  $V \propto \frac{1}{P}$

  $P_1V_1 = P_2V_2$
- **Charles's law:** If m and P are constant

  $V \propto T$

  $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
- **Gay-Lussac's law:** If m and V are constant

  $P \propto T$

  $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
- **Avogadro's law:** If P, V and T are same

  $N_1 = N_2$

  where, N_1 and N_2 are the number of molecules

  $V \propto n$ (no. of molecules of gas)

  $\frac{V_1}{n_1} = \frac{V_2}{n_2}$
- **Graham's law:** If P and T are constant

  rate of diffusion $r \propto \frac{1}{\sqrt{\rho}}$

  $\frac{r_1}{r_2} = \sqrt{\frac{\rho_2}{\rho_1}}$
- **Dalton's law:** $P = P_1 + P_2 + P_3$ ......

  P = Total pressure

  P_1, P_2, P_3 .... = Pressure exerted by each component present in the mixture.
- **Ideal gas equation:** $PV = nRT = k_BNT$

  n = number of moles

  N = number of molecules

  R = universal gas constant

  k_B = Boltzmann's constant
- Pressure exerted by ideal gas

  $P = \frac{1}{3}\frac{mN}{v}\overline{v^2}$

  $\overline{v^2}$ = mean square velocity $\left\{\overline{v^2} = \frac{v_1^2 + v_2^2 + v_3^2 + ...}{N}\right\}$

  m = mass of each molecule

  or $P = \frac{1}{3}nm\overline{v^2}$

  n = number density *i.e.*, $n = \frac{N}{V}$
- $V_{ms} = \left(\overline{v^2}\right)^{1/2}$

  K.E. $= \frac{3}{2}k_BT = \frac{1}{2}m\overline{v^2}$

  $\overline{v^2} = \frac{3k_BT}{m}$

  $\Rightarrow V_{rms} = \sqrt{\frac{3k_BT}{m}}$
- $V_{av} = \sqrt{\frac{8K_BT}{\pi m}}$
- $V_{mp} = \sqrt{\frac{2K_BT}{m}}$
- Mean free path $(\bar{l}) = \frac{1}{\sqrt{2}n\pi d^2}$

  n = number density

  d = diameter of molecule
- $\gamma = \frac{C_p}{C_v}$

  γ = ratio of specific heats

  C_p = specific heat at constant pressure

  C_v = specific heat at constant volume

  $C_p - C_v = R$

  R = universal gas constant

S.No.	Atomicity	No. of degree of freedom	C_P	C_v	$\gamma = C_P/C_v$
1	Monoatomic	3	$\frac{5}{2}R$	$\frac{3}{2}R$	$\frac{5}{3}$
2	Diatomic	5	$\frac{7}{2}R$	$\frac{5}{2}R$	$\frac{7}{5}$

- $C_{v(mix)} = \frac{n_1C_{v_1} + n_2C_{v_2}}{n_1 + n_2}$

  where n_1 and n_2 are number of moles of gases mixed together C_{v_1} and C_{v_2} are molar specific heat at constant volume of the two gas and $C_{v(mix)}$: Molar specific heat at constant volume for mixture.